STRUCTURAL BEAM AND WEB

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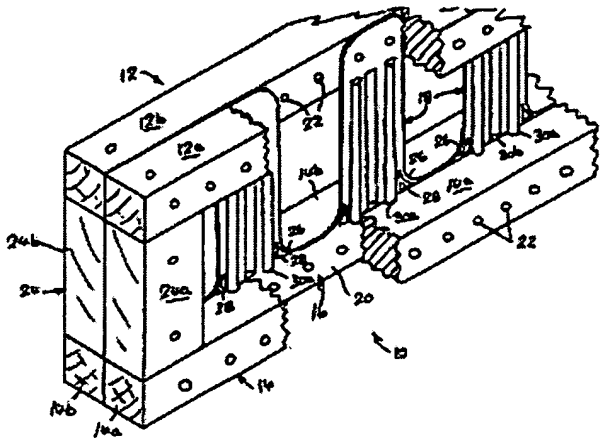
Abstract of **WO9605385**

A composite beam (10) having timber top and bottom chords (12 and 14) and a pressed sheet-metal web (15) is disclosed. The web (15) has a series of stiffened panels (16) arranged at intervals therealong, the panels being joined by a continuous tension strip (17) along at least one edge of the web (15). End studs (20) are also employed. The components of the beam (10) are fixed in place by the nails which pass through the chords (and studs) and the web. Various forms of web are disclosed together with apparatus and methods for assembling the beams.



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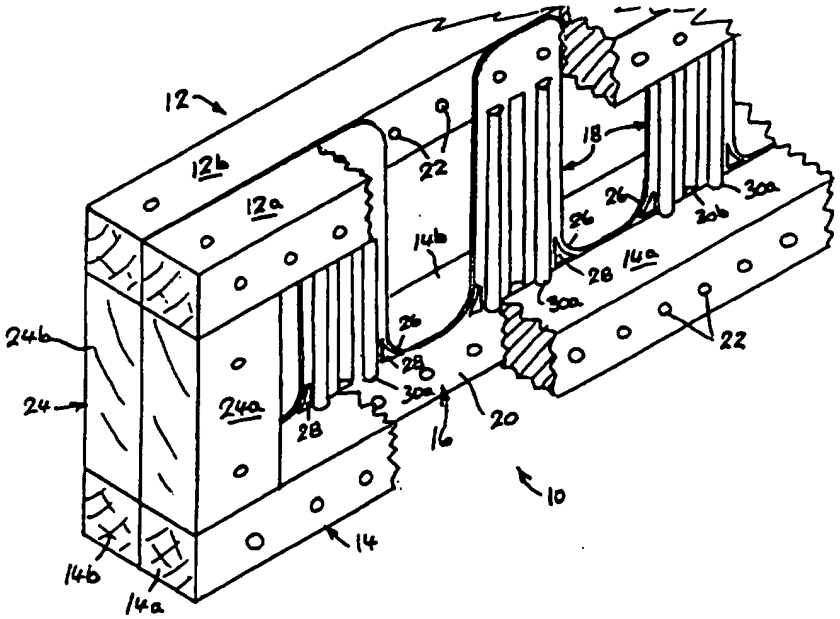

(57) Abstract

A composite beam (10) having timber top and bottom chords (12 and 14) and a pressed sheet-metal web (15) is disclosed. The web (15) has a series of stiffened panels (16) arranged at intervals therealong, the panels being joined by a continuous tension strip (17) along at least one edge of the web (15). End studs (20) are also employed. The components of the beam (10) are fixed in place by the nails which pass through the chords (and studs) and the web. Various forms of web are disclosed together with apparatus and methods for assembling the beams.

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TITLE STRUCTURAL BEAM AND WEB

TECHNICAL FIELD

This invention relates to composite steel-and-timber structural beams and to steel webs for use in such beams. It also concerns methods of forming such beams and to apparatus for use in such methods. The beams with which this invention is concerned find use in supporting spans up to eight metres in domestic and 'low-rise' light commercial buildings. They may be used as bearers, joists, lintels and the like.

BACKGROUND TO THE INVENTION

Composite steel and timber beams have the advantage of being cheaper than structurally equivalent beams formed wholly from timber and lighter and more easily employed in timber structures than steel beams. Such composite beams typically have timber chords and steel webs or braces secured to the timber using integral spikes struck from the steel. It is desirable for such composite beams to be easily manufactured by local roof-truss makers and builders suppliers who service the domestic and light construction industry. It is also desirable for such beams to have openings pre-formed therein to accommodate wiring and piping.

Many truss-like composite beams have been proposed using press-formed, ribbed or flat, rectangular or V-shape spiked connector plates for fixing the timber chords together. Examples are disclosed in US patent Nos. 3,025,577, 3,298,151, 3,503,173, 4,078,352, 4,207,719, 4,348,850 and 4,523,419, and UK patent No. 1,572,354. Thus, US patent 4,523,419 discloses the use of multiple rib-stiffened rectangular spiked plates which are pressed, at spaced intervals, onto the outside faces of a pair of timber chords to create a beam. The stiffening ribs in the plates are deeper than the spikes so that they assist in locating the chords in correct spaced relationship while the plates are pressed home to drive the spikes into the timber. Similarly, UK patent 1,572,354 discloses the use of multiple V-shape spiked braces which are also spaced out along timber chords. While such beams provide plenty of openings for piping and can be fabricated by local truss makers, they require high-grade and continuous timber chords, are laborious to assemble (since there are so many components), difficult to manufacture straight and difficult to handle because of their lateral flexibility.

In my Australian patent No. 650614, I disclosed a variety of beams having timber chords and continuous steel webs in which the webs are roll-formed and punched to produce integral spikes along their upper and lower edges and, if desired, to provide access holes. The webs are attached to the chords by pressing the spikes into the timber chords. Since the webs have continuous upper and lower edges, low-grade timber can be used for the chords. However, few truss-makers or builders suppliers can afford the necessary roll-former, punch and press, so such beams are now only made in central locations.

OBJECTIVES OF THE INVENTION

The general objective of this invention is to provide improved composite beams, improved webs for use in such beams and improved beam fabrication methods and apparatus. It is desirable that such beams be easy to manufacture with few components and low-grade timber, while providing ready access for piping and the like.

OUTLINE OF INVENTION

The present invention is based upon the realisation that an I-form beam with a central sheet-metal web and timber chords can be readily fabricated using nails (preferably from nail-guns), instead of presses to form a coherent and structurally-sound beam. Without the need for spiked steel components, assembly is greatly simplified. Moreover, it was appreciated that, if the web were to have alternating ribbed and plain panels, the ribbed panels would provide the necessary structural stiffness for the beam while the plain panels would give the web sufficient flexibility for it to be supplied to beam-fabricators in coil-form. Furthermore, large access holes could be formed in the plain panels without compromising the strength of the beam, provided at least one continuous edge (tension-strip) was retained.

Conveniently, the web may be of castellated form so that two webs can be produced from a single blank strip, each having a continuous tension-strip along one edge (which will be at the bottom of the beam) and castellations along the other (the top) edge. In that event, the plain panels are essentially reduced to the portion of the tension strip lying between the stiffened panels. Castellated webs having substanti-

ally rectangular (including square) panels are generally most suitable, but panels of triangular (upright or inverted) form may also be employed. It is desirable to include a generous radius between each side edge of each stiffened panel and the tension-strip(s) for reinforcement.

Alternatively, the web may be formed with continuous top and bottom tension strips between which the alternate stiffened and the blank (or holed) panels or spaces are located. The tension strip(s) may be integral with the panels or the web may be assembled from separate tension strip(s) and discrete ribbed panels arranged at spaced intervals. The strip(s) and panels may be fixed together (as by spot-welding) and supplied as a coiled web, or they maybe supplied separately and fixed together (with the timber chords) when the beam is nailed.

The ribs of the stiffened panels of the web are preferably formed so that they will be orthogonal to the chords of the finished beam and so that their ends are aligned in such a manner as to locate the upper and lower chords (on each side of the web) in spaced relation to one another. For this purpose, adjacent ribs are preferably pressed from opposite sides of the web and each end of each rib is cut from the body of the web so as to form a well-defined shoulder to bear against the adjacent timber chord.

To assemble a beam using such strip-form webs, all that is required is to lay a pair of timber chord halves on a bench or in a horizontal jig so that they are coplanar and in parallel spaced relationship with one another, lay the desired length of web on top of the chord halves so that the ends of the ribs of the web contact and separate the chord halves, lay another pair of chord halves on top of the web so that they are similarly aligned and separated, hold or clamp the components together in alignment, and finally, nail into and along the upper chord halves to secure the components permanently together (the nails penetrating through the upper chord halves, through the material of the web and into the lower chord halves). It is also envisaged that the web may be arranged in a vertical rather than a horizontal plane while the chord halves are arranged and clamped in place, the nails then being driven horizontally

through the web and the chords. This has the advantage of allowing nails to be driven from both sides of the beam.

The assembly of a piece-form web can follow essentially the same sequence except that the ribbed plates will be laid out along the first pair of chord halves and then the tension strip(s) will be laid over the plates and the chord half(ves) before the second pair of chord halves are laid on top, clamped and assembled.

As already indicated the web can be supplied flat in modular lengths or it may be coiled and supplied in coil form. If coiled and of the castellated form, it may be convenient to supply the intermeshing and castellated web-halves as a coiled unit, the two castellated webs being attached to one another by thin ties or tabs of the uncut material of the strip so that they can be readily separated, allowing one web to be uncoiled without having to uncoil the other. A (single-web or double-web) coil can be transported readily with or without supporting reels and can be mounted on suitable reels for uncoiling at the site where the beams are to be fabricated. In that event, it will be convenient to fit straightening rolls or guides to straighten the web as it is pulled from the coil and drawn into or along the jig for forming the beam.

From another aspect, the invention comprises a load-bearing panel formed from sheet-metal for use as part of the vertical web of an I-beam having top and bottom chords formed from lengths of timber, said panel having: substantially flat horizontally-extending upper and lower faces on each side thereof adapted for interposition between pairs of top and bottom chord-elements, each face having a depth approximating that of the respective chord-elements, and a plurality of vertical stiffening ribs pressed into or struck from the portion of the panel intermediate between said upper and lower faces so that at least one rib protrudes from each side of the panel and so that the bottoms of the ribs terminate at the top of said lower faces and the tops of the ridges terminate at the bottom of said lower faces, the ribs thereby being adapted to vertically locate the top and bottom chords of a beam with respect to each other.

From another aspect, the invention may comprise a composite I-beam including a central metal web of the type indicated above and timber chords elements along both sides and both edges of the web, the opposing chords elements along one edge of the web being nailed together by nails passing through the web to form a complete top or bottom chord.

From yet another aspect, the invention comprises a method of constructing a structural beam including the steps of: arranging a first pair of timber half-chord elements in parallel, spaced and coplanar relationship, laying a web of the type indicated above against the chord elements so that the unstiffened portions of sides of the web lie upon first pair of half-chord elements, placing a second pair of half-chord elements in a similar manner against the other side of the web opposite the first pair of half-chord elements and nailing the opposing chord elements together through said unstiffened portions of the sides of the web to complete the top and bottom chords of the beam and, indeed, to complete the beam itself.

The method may include the step (before nailing) of moving each pair of chord elements toward one another while in contact with the web until their inner faces abut with the ends of the stiffening ribs of the web, so that the spacing of the upper and lower chords is positively determine before nailing. It may also include the step of drawing a length of web from a coil linearly over the first pair of half-chord elements so that it lies thereon. Further, the method may include mechanically supporting at least one nail gun in juxtaposition with a chord element and drawing it along said element while driving nails therein at regular intervals. Alternatively, the method may include feeding an assembled beam past at least one fixed nail-gun and operating the gun(s) to drive nails through one or both chords at regular intervals therealong.

From yet another aspect, the invention may comprise apparatus for forming composite beams, the apparatus including a linear jig for holding a pair of timber chords in spaced parallel and coplanar relationship, means for mounting a coil of strip-form web so that a length of web may pulled (and uncoiled) therefrom and laid upon or against a pair of chord elements held in said jig, and clamp means for

clamping a second pair of chords against the web and the first pair of chords while providing access to allow the opposing chord elements to be nailed together through the web.

DESCRIPTION OF EXAMPLES

Having broadly portrayed the nature of the present invention, particular embodiments will now be described by way of example and illustration only. In the following description, reference will be made to the accompanying drawings in which:

Figure 1 is a perspective view of a composite I-beam, with portions of chord broken away, formed in accordance with this invention.

Figures 2A, B and C are perspective views of alternative webs which may be employed in the beam of Figure 1.

Figures 3A, B and C are side elevations of steel strip-blanks perspective illustrating some different ways in which a pair of identical castellated webs may be cut from such strips without waste.

Figure 4 is a perspective view of a second example of a beam formed in accordance with this invention.

Figures 5A, B and C illustrate other alternative forms of web suitable for use in composite beams envisaged herein.

Figures 6A and B are, respectively, a diagrammatic side and an end elevation of a beam-jig apparatus suitable for use in assembling the beams of this invention.

Figures 7A and 7B are, respectively, a diagrammatic side and end elevation of a beam-nailing apparatus.

Figure 1 illustrates an I-beam 10 which will serve to exemplify various aspects of this invention. It basically comprises split top and bottom chords 12 and 14 formed from timber (top chord 12 comprising front and rear chord-halves or elements 12a and 12b and bottom chord 14 having front and rear elements 14a and 14b) and a sheet-metal web 16, comprising spaced vertical rib-stiffened web-panels 18 and a longitudinal bottom tension strip 20, sandwiched between the elements of chords 12 and 14 and secured in place by nails 22. Beam 10 is terminated at each end by an end-stud 24 comprising — in this example — front and back half-studs 24a and 24b

nailed together and to the respective chord elements. Alternatively, the end-stud halves may be formed by metal plates nailed to the respective chord halves or incorporating integral spikes which are driven into the chord elements.

Web 16 is in the form of a castellated strip with generous fillets 26 between the junction between panels 18 and tension-strip 20, each fillet having a triangular stiffening indentation 28 to further strengthen this portion of web 16. As Figure 2A illustrates this general type of web (which differs only in that fillets 26 are omitted and four ribs are employed per panel instead of 3), the same reference numerals will be used as for Figure 1. Each rib-stiffened panel 16 has forwardly projecting stiffening ribs 30a and rearwardly projecting ribs 30b pressed therefrom, the ribs being of a semi-circular section in this case. Both ends of all ribs are cut from the material of their panels 18, the bottom ends being aligned along the web with the top of tension-strip 20 (and, therefore the top of lower chord 14), and the top ends of the ribs being aligned with the bottom face of upper chord 12.

The aligned ends of ribs 30 thus form a pair of shelves, or aligned rows of stops, against which the chord-elements can be abutted to assist in their correct location during assembly of the beam. This desirable effect can be achieved with a variety of different stiffeners. Figure 2B shows a web 16b with similar stiffening ribs 31 in panels 18b, but in this case, the ribs are of trapezoidal section. The web 16c of Figure 2C includes a similar shape of stiffened panel 18c, but in this case ribs 31a are punched-out as vertical flaps from the material of the web.

It will be readily appreciated that two castellated webs of the types shown in Figures 1 and 2 may be pressed from a single strip-blank in a single pass without waste. Other forms of castellated webs may also be produced in this manner. Figure 3A diagrammatically indicates the way two webs 32 with rectangular-form panels 33 may be cut from a strip 34. Figure 3B similarly shows how two webs 35 with 'upright' triangular-form panels 36 may be cut from the strip 34, while Figure 3C shows how webs 37 with 'inverted' triangular-form panels 38 may be cut from the strip 34. For the sake of clarity, the stiffening of panels 33, 36 and 38 is not shown.

Figure 4 illustrates a beam 40 employing the inverted triangular web 37 of Figure 3C, with stiffening ribs 42. In this case, however, the top and bottom cords 44 and 46 are slotted rather than completely split to take the web. As before, the chords are fixed to the web by nails 48.

Figures 5A-C show still further variants for the web. That of Figure 5A is a non-castellated web (50) which has integral top and bottom tension-strips 51 and 52, allowing beams with this web to be mounted either way up. The stiffened panels 53 are alternated along the web with openings 54. Figure 5B shows a fabricated web formed from separate stiffened panels 55 spaced along the web and joined together (as by spot-welding) by a separate bottom tension strip 56 and, optionally, by a top tension strip 57 shown in broken lines. Panels 55 and tension-strip 56/57 need not be assembled to form the web prior to beam fabrication as they can be laid-up on a pair of chord-elements and then joined by the nails which fix the chord elements together. This allows the gaps between panels 55 to be tailored to the length of the span and the access for piping required. While such webs also avoid the waste of material associated with the pressing of web 50, the penalty of fabrication labour must be accepted. Nevertheless, both the webs of Figures 5A and 5B are readily coiled.

The web 58 of Figure 5C is an example of one which does not have any holes for piping or wiring, but provision for such holes can be made by scoring circles 59 in the unstiffened panels 60. In this example, lugs 61 are stamped and folded outwards from each end of the stiffened panels 62 to form the stops for the location of the chord elements. While such a web can be readily coiled, lugs 61 are struck from the upper and lower tension strips 63 and 64 so reducing the load which could otherwise be carried by the beam.

One form of apparatus (100) for forming beams such as that illustrated in Figure 1 is shown in Figures 6A and 6B. Here a coiled double-web 102 is supported on a stand 104 so that a single web 106 can be pulled off the coil, through straightening rolls 108 and laid on a pair of timber chord-elements 110 resting in an open clamping-jig 112 that is supported on a table 114. The second pair of chord

elements 116 are then laid in place on top of the edges of web 106 and clamped down onto web 106 and chord elements 110 by spring-clamps 118. For clarity, spring-clamps 118 are shown on one side of the clamping-jig only (though they will usually be used on both sides) and, in Figure 6A, they are shown indicatively at 118'.

Clamping jig 122 is formed in two longitudinal halves, a fixed half 112a and a moving half 112b which can be moved together or apart by hand-screws 120. After spring-clamps 118 have been applied, hand-screws 120 are operated to move clamp-half 112b toward clamp-half 112a and force the members of each pair of chord elements toward one another by sliding them on the flat edges of web 106 until they abut stiffening ribs 106a of the web panels, thus correctly aligning all the principal parts of the beam.

After the components of the beam have been clamped and aligned as described, each pair of vertically aligned chord elements (consisting of one element 110 and one element 116) may then be nailed together by using nail-gun 122. Gun 122 can be held and moved by hand but is preferably supported and guided on rails located above the beam. A nail 124 is shown in place in Figure 6B.

After nailing has been completed, the beam is trimmed to length by docking blade 126 which also cuts through web 106. If desired, a pair of shears for cutting the web by itself may be substituted for the docking blade and the web may be cut to length before the beam is assembled rather than after. As no provision is made in this apparatus for the attachment of studs or stud-plates to the ends of the beam, this will need to be done manually or in a press in a subsequent operation.

As will be noted from Figure 6A, the upper and lower chord elements need not be continuous lengths of timber, so long as the butt-joins in them do not coincide. Little tensional force need be carried by the lower timber chord when the beam is in place with the tension-strip of the web at the bottom. Nevertheless, it is preferable to finger-joint the chord elements so that the tensional strength of the timber is added to that of the tension-strip of the steel web and the lateral stiffness of the beam is improved.

A semi-automated apparatus for clamping the beam elements and nailing them together is diagrammatically illustrated in Figures 7A and 7B. Here, one pair of timber chord elements 200a and 200b is laid on a work-bench 202 so that front element 200a lies along the rear face of a vertical stop-plate 204 that is fixed to bench 202, and so that rear element 200b abuts with the front faces of a series of clamp-pads 206 that can be moved forward and rearwards by associated pneumatic actuators 208. At this stage, actuators 208 are set so that pads 206 are withdrawn to a fixed rear position. The web 208 for the beam is then laid on spaced elements 200a and 200b and a second pair of chord elements 210a and 210b is then laid on the web in similar positions to the first pair of elements 200a and 200b. Actuators 208 are then operated to bring all the chord elements and the web into correct alignment, but without using sufficient pressure to force the chord elements over the stiffening ribs 208a of web 208.

A pair of nail-guns 212 is suspended from an inverted-T rail 214 that is arranged above (and in alignment with) the approximate centre of the beam are laid-up, each gun being suspended directly over a chord of the beam. Rail 214 is in turn suspended from a series of cantilever arms 215 that are supported by posts 215a. Guns 212 themselves are mounted by their top faces to the lower face of a slider plate 214 that can be raised or lowered by a pneumatic actuator 216 with respect to a carriage 218 that is mounted by rollers 220 for sliding motion along rail 214. A vertically-operable clamp 222 is arranged on each side of the pair of guns 212 and comprises a foot-plate 224 pivotally attached to the lower end of a pneumatic actuator 226 that is, in turn, bolted to a pedestal 228 which is directly secured to the bottom face of carriage 218.

While the components of the beam on workbench 202 are being laid-up and lightly held horizontally in place by actuators 208 as described above, carriage 218, together with its various appendages, is located out of the way at one end of the beam. It is then driven stepwise along rail 214 so as to stop at each location where a pair nails is to be driven into the timber chord elements. When carriage 218 is to be moved, the guns are raised by actuator 216 and foot-plates 224 are released (raised) by actuators 226, and when the carriage is stopped ready for nailing to take

place, clamps 222 are lowered onto timber elements 210 to position them vertically. If desired, the nearest horizontal clamp actuators 208 may be actuated to apply a final level of pressure to the chord elements. Actuator 216 is then operated to lower slider plate 214 so that the ends of guns 212 are brought into contact with chord elements 210 to automatically drive a pair of nails into the chords through web 208. The guns are then raised by actuator 216 and vertical clamps 222 are released by actuator 226 so that carriage 218 can be moved to the next nail position and the process repeated.

While a drive and control mechanism for the apparatus of Figures 7A and 7B have not been described, these can readily be constructed by those skilled in the art. It will also be appreciated by such persons that more than one nail-gun carriage may be employed over a single beam at one time. Similarly, it will be appreciated that the nail guns can be fixed while the un-nailed beam is drawn past them, rather than the reverse as described in the selected examples. Also, there is no need for the beam components to be laid-up with the web horizontal as the nail guns can be arranged to drive nails at any angle and, with appropriate jigs, the beam components can be laid up with the web vertical or at any convenient angle to the horizontal.

Finally, to assist in laying-up a beam for nailing, it is envisaged that a series of shallow spikes could be struck from the edges of the web at the time it is pressed. This will be of value where the beam is being laid-up on site and hand-nailed as it will assist the chord elements to be retained in place once they have been lightly pressed or hammered onto the edges of the web. On the other hand, such spikes will make the handling of the web more difficult and they will make the jig-based assembly of beams rather awkward.

It will be appreciated by those skilled in the art that composite beams of the type disclosed herein have considerable advantages in terms of cost and convenience with respect to all timber or all steel beams. It will also be appreciated that considerable savings and convenience are offered by permitting beams to be fabricated to order by truss-manufacturers, builders suppliers or even on-site by individual builders using common sections of timber which are ready to-hand.

Nevertheless, it will also be appreciated that many variations and additions can be made to the beams, webs, methods and apparatus disclosed herein without departing from the scope or spirit of this invention as set out in the following claims.

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CLAIMS

1 A load-bearing panel formed from sheet-metal for use as part of the vertical web of an I-beam having top and bottom chords formed from lengths of timber, said panel having:

- substantially flat horizontally-extending upper and lower faces on each side thereof adapted for interposition between pairs of top and bottom chord-elements, each face having a depth approximating that of the respective chord-elements, and
- a plurality of vertical stiffening ribs pressed into or struck from the portion of the panel intermediate between said upper and lower faces so that at least one rib protrudes from each side of the panel and so that the bottoms of the ribs terminate at the top of said lower faces and the tops of the ridges terminate at the bottom of said lower faces,

the ribs thereby being adapted to vertically locate the top and bottom chords of a beam with respect to each other.

2 A coilable, elongate sheet-metal web for use in the fabrication of structural I-beams which have top and bottom chords formed from lengths of timber and which are normally mounted with their webs vertical, the web comprising:

- a plurality of stiffening panels as claimed in claim 1 arranged in spaced coplanar relation to one another along the length of the web so that their upper and lower faces are respectively aligned, and
- a continuous, substantially flat and horizontal tension-strip extending along the bottom portion of the web joining the stiffening panels together along their lower faces, thereby forming flexible sections between the panels so that the web may be coiled.

3 A web according to claim 2 wherein a gap or hole is formed between adjacent stiffening panels which is devoid of the metal of the web, the gaps or holes providing access spaces at intervals along the length of a beam formed from the web.

4 A web according to claim 2 or 3 wherein: said tension-strip is formed integrally with the stiffening panels, a fillet is formed at the junction of each vertical side edge

of each stiffening plate and the tension strip, and an indentation of triangular shape is formed in the fillet to stiffen it.

5 A web according to any one of claims 2-4 characterised in that:

- it is of castellated form having only one continuous edge (the lower edge comprising the tension-strip) and having gaps between adjacent stiffening panels which extend to the top edge of the web,
- it is formed by pressing it and another identical complementary interleaved castellated web from a single strip of sheet metal without waste, and
- it is coiled together with said complementary interleaved castellated web for transport.

6 A coilable, elongate sheet-metal web for use in the fabrication of structural I-beams which have top and bottom chords formed from lengths of timber substantially as herein before described with reference to any one of Figures 1 to 5.

7 A structural I-beam having a web formed of sheet-metal and having top and bottom chords formed from lengths of timber, characterised in that the web includes stiffening panels formed in accordance with claim 1.

8 A structural I-beam having top and bottom chords formed from lengths of timber and a web formed from sheet-metal substantially as claimed in any one of claims 2 to 7.

9 A structural I-beam substantially as herein before described with reference to Figure 1 or Figure 4 of the accompanying drawings.

10 A structural I-beam comprising:

- a central sheet-metal web as claimed in any one of claims 2 to 6,
- an upper timber chord element on each side of the top edge of the web, each upper element being transversely located by the top ends of the ribs of the stiffening panels of the webs,

- a lower timber chord element on each side of the bottom edge of the web, each lower element being transversely located by the bottom ends of the ribs of the stiffening panels of the webs,
- nails driven through the upper the chord elements and the top edge of the web securing these components together, and
- nails driven through the lower chord elements and the bottom edge of the web securing these elements together.

11 A beam according to claim 10 wherein the upper chord elements are formed by longitudinally slotting a length of timber to accommodate the top edge of the web, and/or the lower chord elements are formed by longitudinally slotting a length of timber to accommodate the bottom edge of the web.

12 A method of forming a structural beam incorporating the web claimed in any one of claims 2 to 6, comprising the steps of:

- arranging a first pair of top and bottom timber chord elements along and against the top and bottom edges (respectively) of one side of the web so as to abut the top and bottom ends (respectively) of the stiffening ribs and so as to be held in spaced parallel coplanar relationship with one another,
- arranging a second pair of top and bottom timber chord elements along and against the top and bottom edges (respectively) of the other side of the web so as to abut the top and bottom ends (respectively) of the stiffening ribs and so as to be held in spaced parallel coplanar relationship with one another, and
- nailing the top chord elements together through the top edge of the web, and
- nailing the bottom chord elements together through the bottom edge of the web to complete the top and bottom chords of the beam.

13 A method according to claim 12 comprising the step of drawing a nail gun, which is mounted adjacent a chord, along that chord and automatically triggering the firing of nails at regular intervals into the chord by the gun.

14 A method according to claim 12 comprising the step of drawing the assembled beam components past at least one nail gun arranged in close proximity to the chord

or chords of the beam and automatically triggering the firing of nails into the at regular intervals into the chord or chords by the gun or guns.

15 Apparatus for forming composite beams, the apparatus including a linear jig for holding a pairs of timber chord elements in spaced parallel and coplanar relationship, means for mounting a coil of strip-form web of the type claimed in anyone of claims 2 to 6 so that a length of web may pulled (and uncoiled) therefrom and laid against a first pair of chord elements held in said jig, first clamp means for clamping the edges of the web between the first pair of chord elements and a second pair of chord elements, and second clamp means for clamping the elements of each chord against the adjacent ends of the ribs of the stiffening panels of the web, the beam thereby being held ready for nailing.

16 Apparatus according to claim 15 comprising:
a rail mounted parallel to the jig, a carriage mounted for sliding movement on the rail along the length of the jig, a nail gun mounted on the carriage so that its nose lies in proximity to a chord of a beam to be nailed and so that it is moved along that chord when the carriage is slid along the rail, and control means for automatically firing nails from the gun at regular intervals into the chord as the gun is moved therealong.

17 Apparatus according to claim 16 comprising:
a first actuator adapted to lower the nose of the gun into contact with the chord prior to firing of the gun and to raise the nose of the gun from the chord to allow the gun to be moved to the next position, and at least one second actuator mounted on the carriage adapted to clamp the chord elements together during the firing of the gun and to release the elements to allow the gun to be moved to the next position.

18 Apparatus substantially as herein before described with reference to Figures 6A and 6B or 7A and 7B.

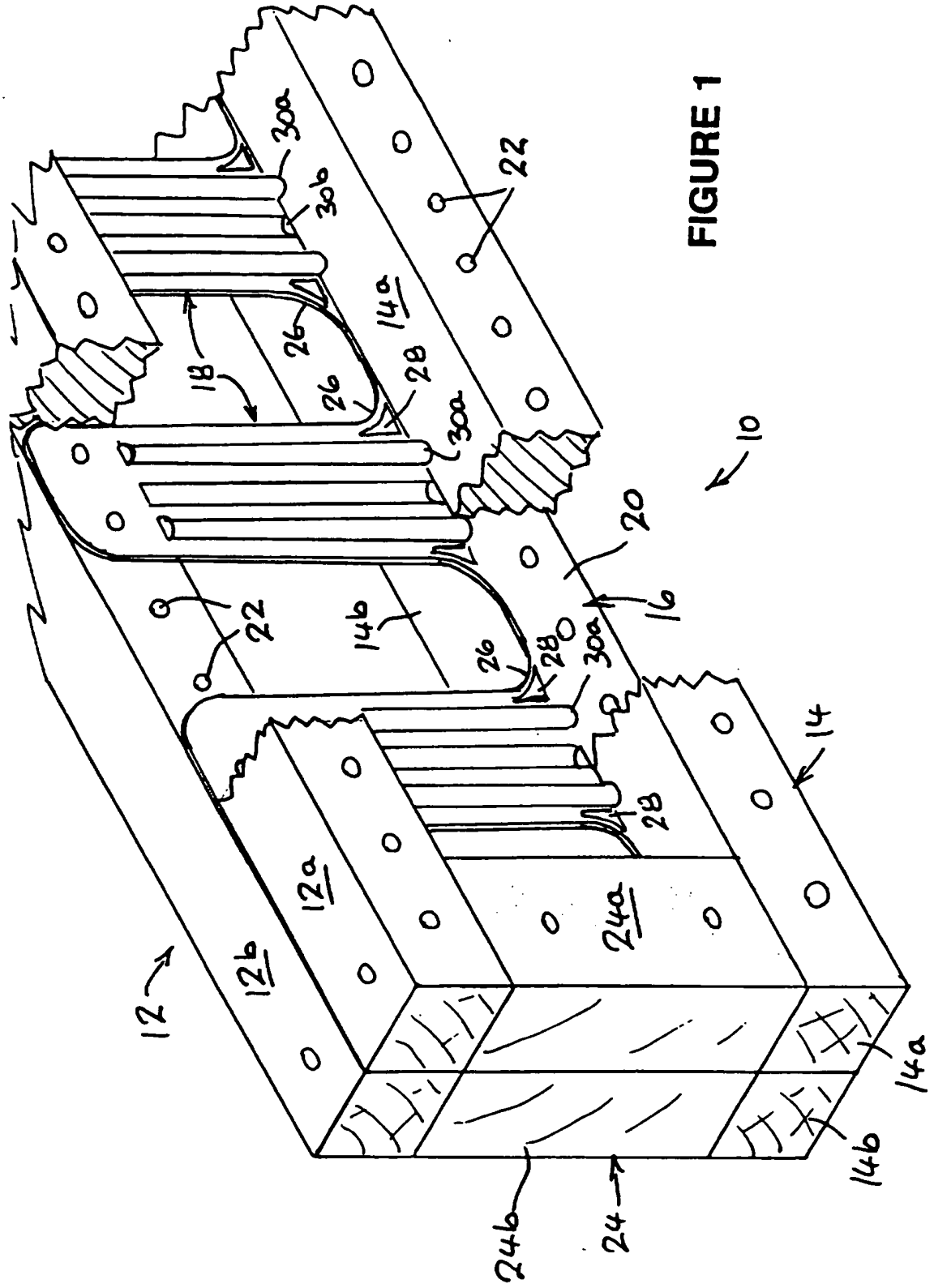
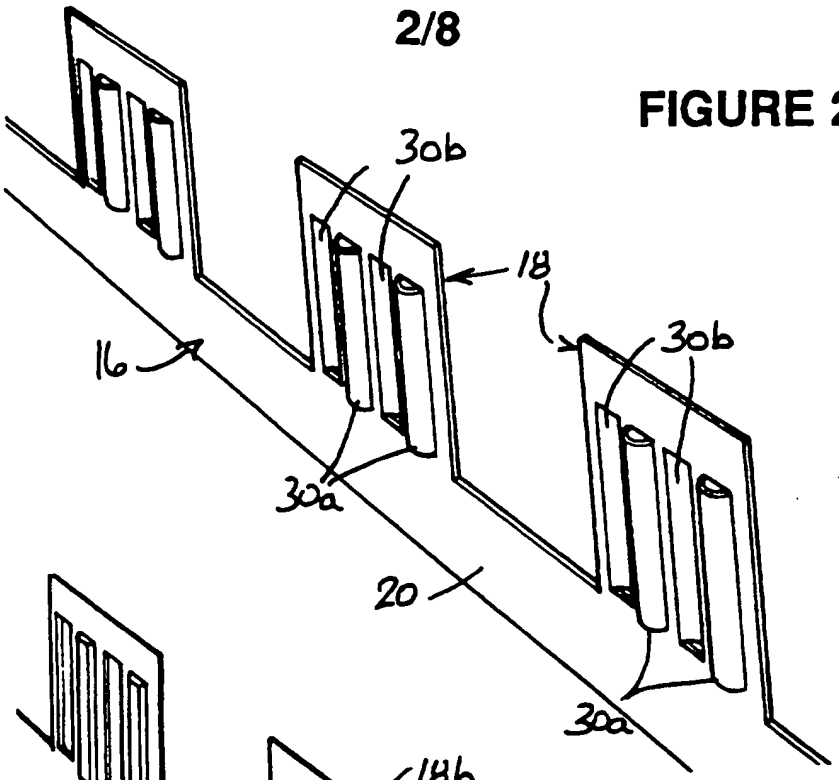


FIGURE 1

FIGURE 2A



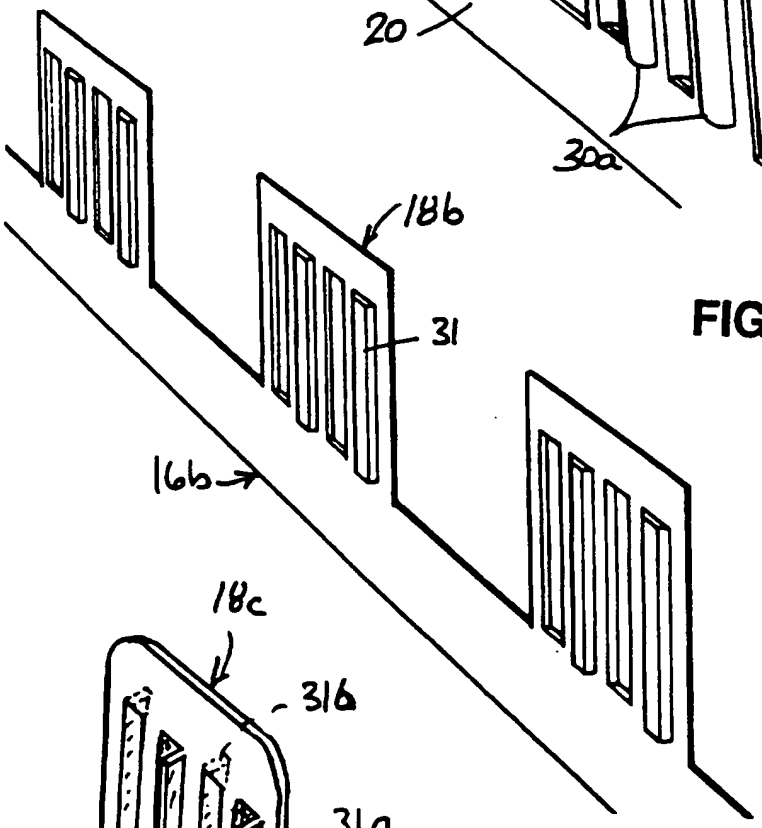


FIGURE 2B

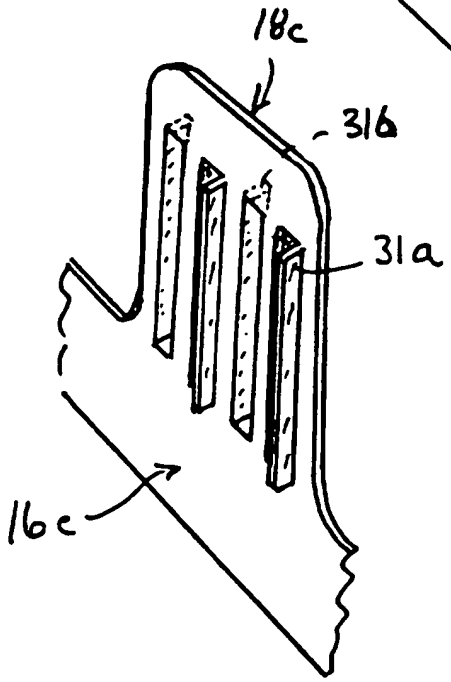


FIGURE 2C

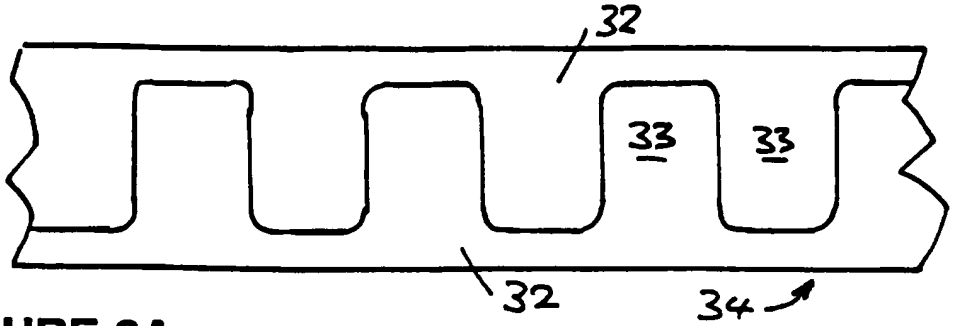


FIGURE 3A

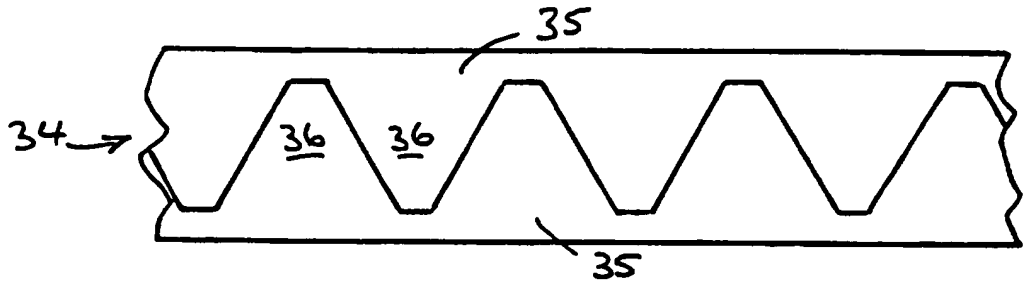


FIGURE 3B

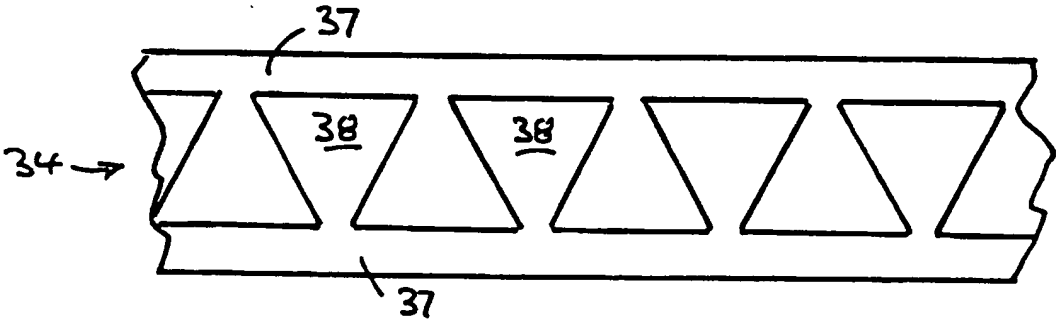


FIGURE 3C

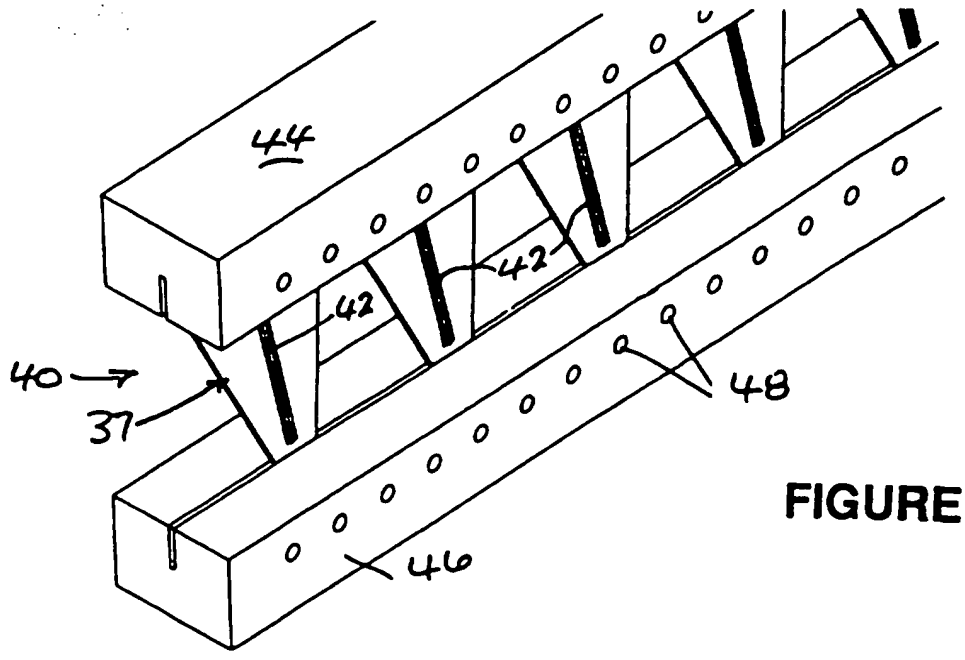


FIGURE 4

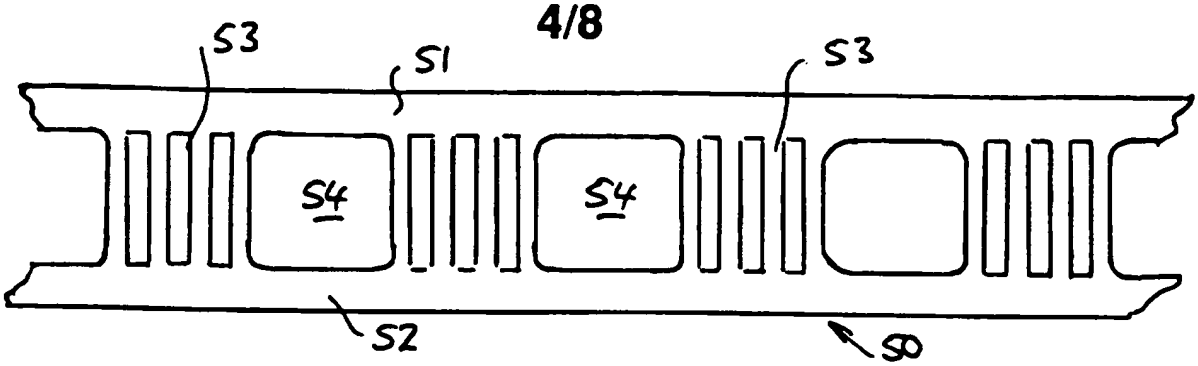


FIGURE 5A

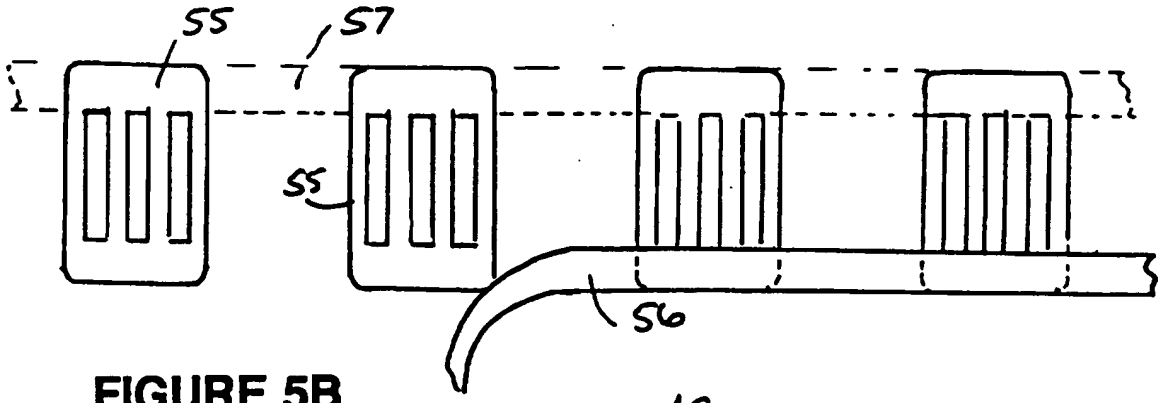


FIGURE 5B

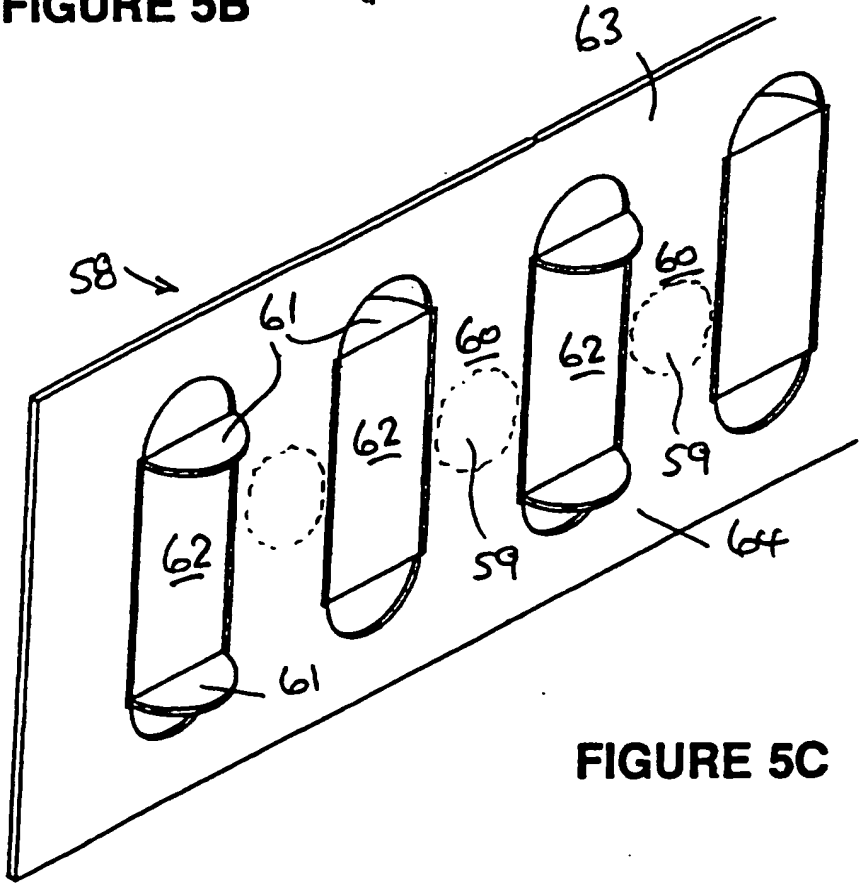


FIGURE 5C

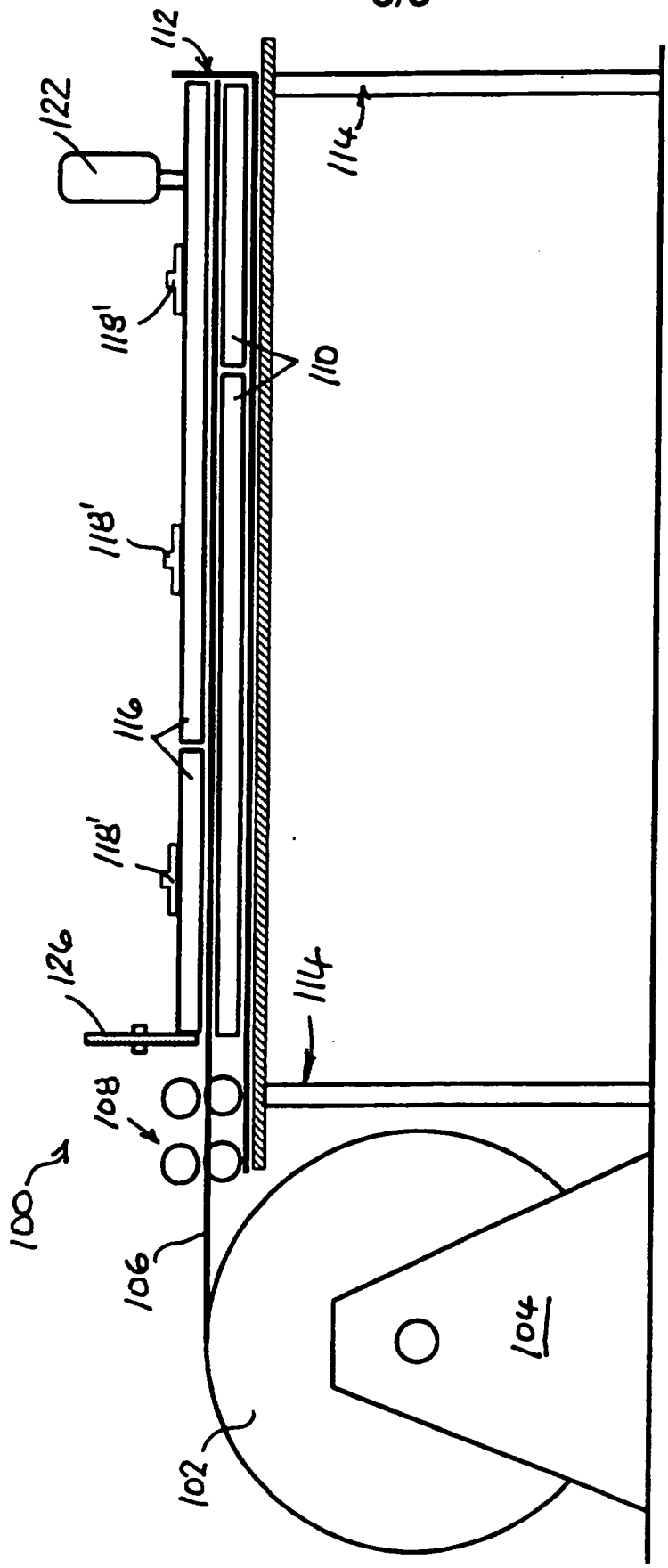


FIGURE 6A

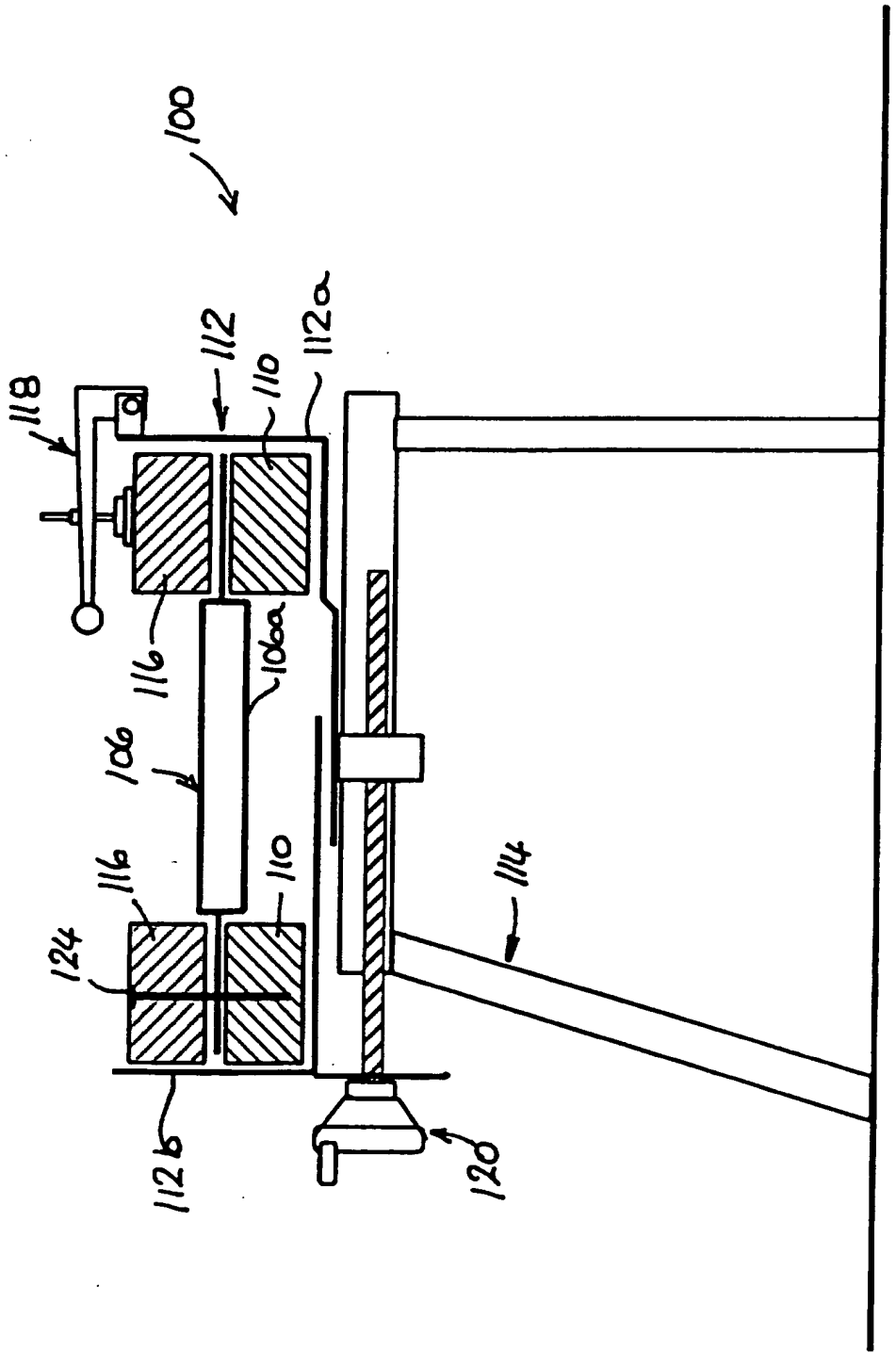


FIGURE 6B

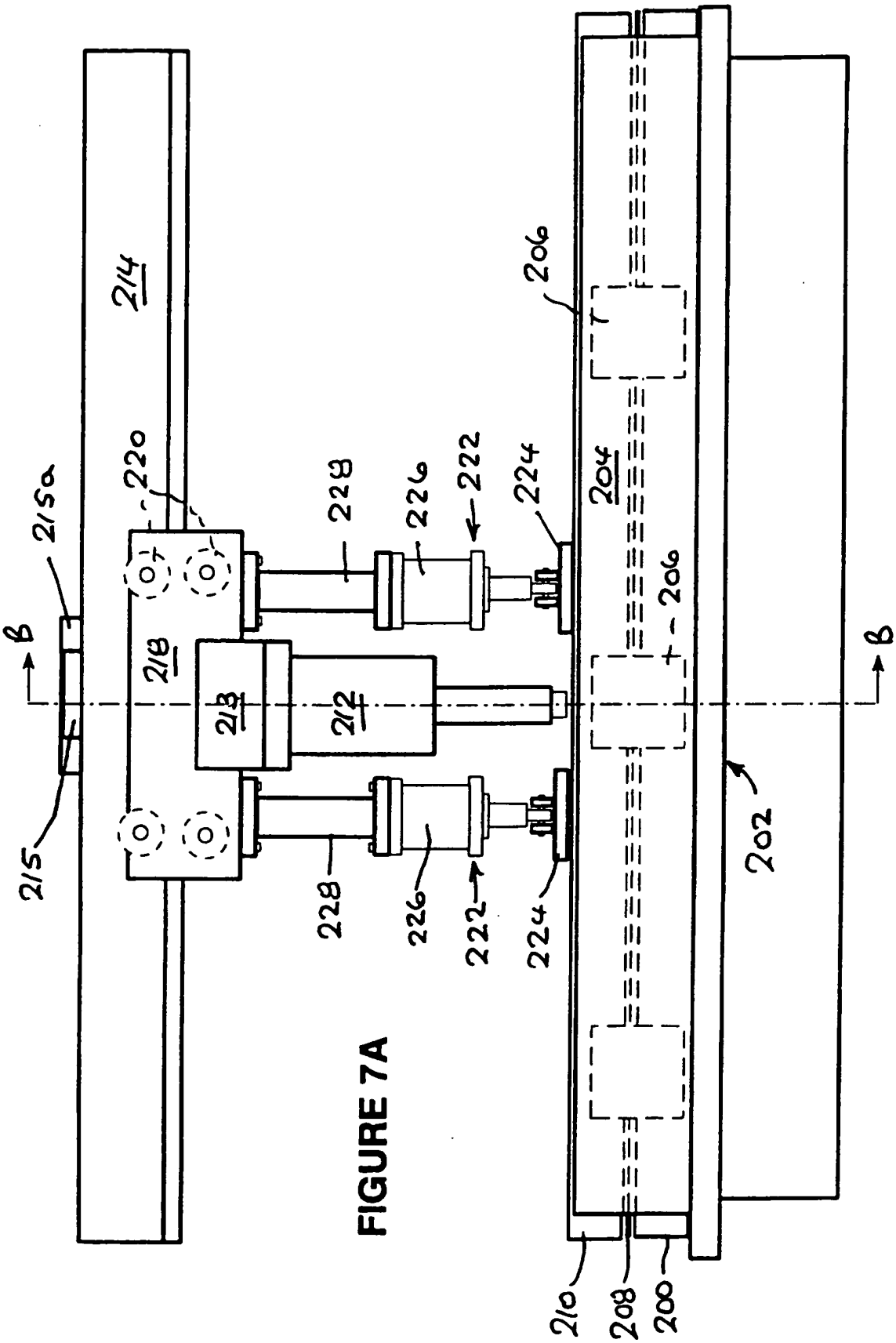

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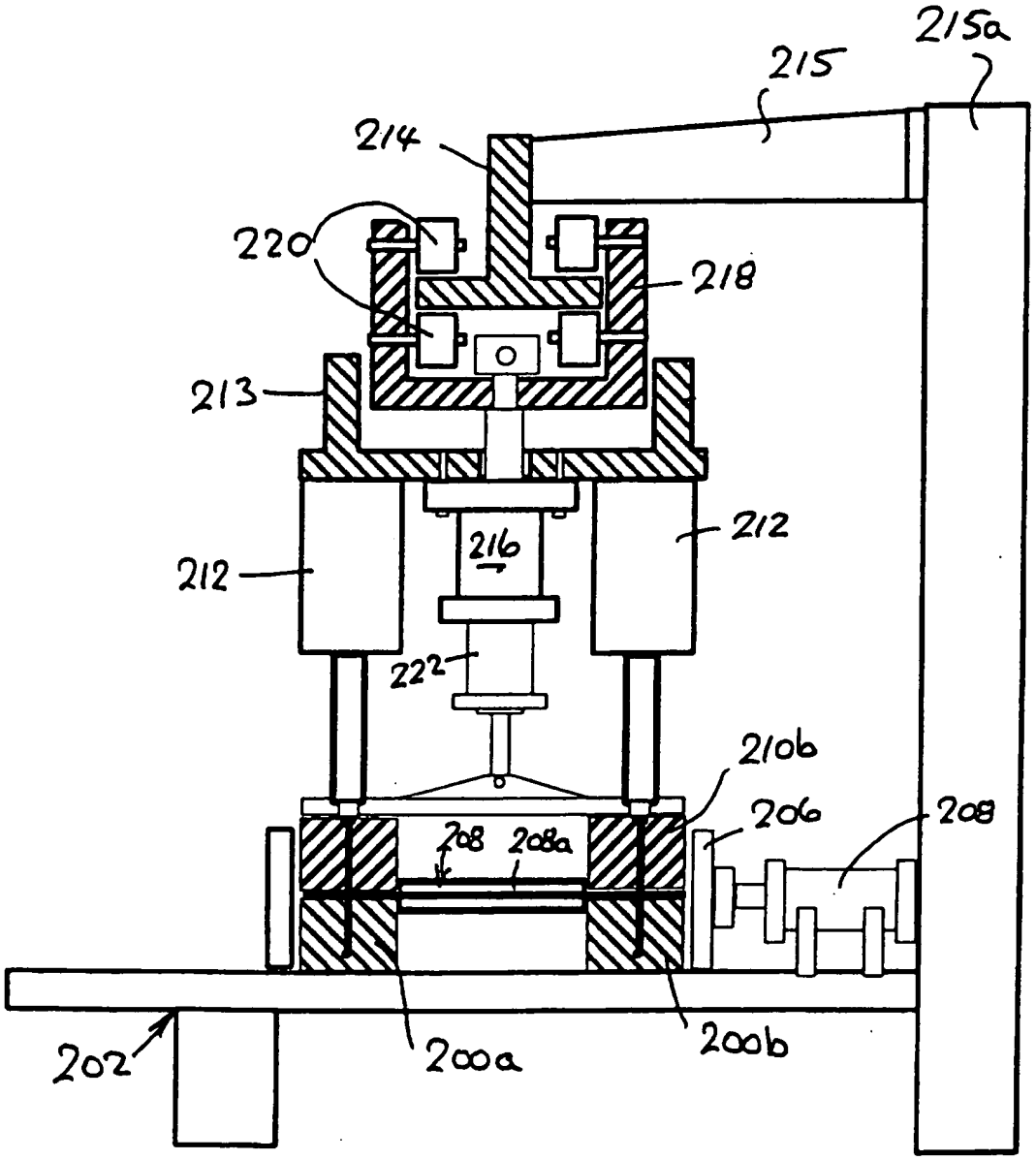
FIGURE 7A

FIGURE 7B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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/000494

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: E04C 3/292 3/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC E04C 3/292 3/16 3/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU:IPC As above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT
JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 708 942, A, (LEONARD) 9 January 1973 See in particular column 3 line 3 - line 29, Figures 1, 2	1, 7
X	EP 282 424, A1 (PHENOL ENGINEERING) 14 September 1988 See column 3 line 14 - column 4 line 29 and figures 1, 2	1
X	WO 89/11011, A1 (NANKIN) 16 November 1989, page 6 line 2 to page 7 line 3 and figures 4 and 7	1, 7

[X] Further documents are listed in the continuation of Box C

[ ] See patent family annex

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search
20 October 1995

Date of mailing of the international search report
02.11.1995

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C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 253 223 A, (DAYKIN) 2 September 1992 See page 6 line 19 - page 8 line 20, and figures 4, 7 and 10	1, 7
A	WO 93/11323 A1 (WEGLER) 10 June 1993 See entire document	1-18
A	WO 94/23149 A1, (BASS) 13 October 1994 See entire document	1-18

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	3708942						
EP	282424	FR	2611857				
WO	8911011	AU	35499/89				
GB	2253223						
WO	9311323	AU	30997/92	PL	302980	SE	9103578
WO	9423149	AU	6692/94				

END OF ANNEX